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AN EVALUATION OF TWO MEASURES OF COMPETITION FOR NATIONAL FOREST TIMBER SALES

by

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Abstract

The National Forest Management Act requires adequate monitoring systems to screen timber sales for collusive activity. This paper evaluates two measures of competition--overbid and the bid-appraisal ratio--in terms of their ability to provide a consistent measure of competition over time. If the purpose of the monitoring is to detect collusion in an individual sale, either measure is adequate. If the purpose of the monitoring is to evaluate competition over time, overbid is preferred.

KEYWORDS: Stumpage sales arrangement, stumpage prices, price determination, National Forest administration.

BACKGROUND

The National Forest Management Act (U.S. Laws, Statutes, etc. 1976) has focused attention on measuring the extent of competition for USDA Forest Service timber sales. The Act requires "adequate monitoring systems" to screen timber sales for collusive activity. From a practical standpoint, sale monitoring can be interpreted two ways: (1) Can individual sales be screened to determine if a sale was sold competitively? (2) Can groups of sales be screened to determine if noncompetitive bidding patterns exist over time? Corrective action is to be implemented once collusion has been detected.

Implementing a monitoring system requires that each sale be evaluated (after being sold) as either competitive or noncompetitive. In competitive sales, a number of buyers interact to establish prices that reflect the underlying supply and demand forces. The problem in monitoring sales is deciding whether a sale is competitive. An obvious measure would be number of bidders. All sales with only one bidder could be classified as noncom-

petitive, but, as Stigler (1966) points out, just the existence of a number of bidders does not mean that they have not colluded. On the other hand, a lack of bidders or a low bid price does not necessarily imply collusion.

The alternatives to the measures which have been tried are the bid appraisal ratio and overbid. The bid appraisal ratio is the more widely used of the two and is a ratio of total bid (net of road costs) to the appraised price.[1/] Overbid is total bid minus road costs and the appraised price.[2/] Both prices and costs are expressed on a per-thousand-board-foot basis. The two measures describe the premium (the amount over the minimum bid) that bidders are willing to pay for the timber on a particular sale. Either of these measures can be used to classify sales as noncompetitive or competitive by selecting sales with only limited competition and consequently whose premium is less than some arbitrary amount. This amount is usually established at a level that will single out "token bid" sales as being noncompetitive. Sales of this type are typically seen as those in which a number of bidders might be involved but only one bidder makes a token bid of, say, 5 cents over the appraised price.

The Question

The existence of two measures of competition raises the question of whether the measures are equivalent or whether there are unique differences making one measure more appropriate. The objective of this note is to examine the measures to determine which is better in the sense of uniformly evaluating competition on USDA Forest Service timber sales.

The question of uniformity involves the nature of the rating each measure assigns to a sale. The issue is whether the assigned rating is unique to each sale or only relative. For example, do the measures result in ratings that are temporally consistent; that is, do the measures assign the same value to two sales which have identical physical characteristics and bidder response if they are observed at different points in time? The measure which provides the more consistent rating is assumed to provide the better measure of competition.

The Appraisal Process

The USDA Forest Service appraisal process assigns to stumpage the residual of the estimated value of the mix of products which could be manufactured from the timber on a given sale minus the logging, manufacturing, and road costs estimated for that sale. An additional adjustment is made for profit and risk. As an example, suppose that the product selling value of a particular sale is $159 per thousand board feet; that is, the products that could be manufactured, including byproducts (e.g., chips), are worth $159 per thousand. The logging costs for the particular sale and the manufacturing

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[1/] Mead (1966) and Mead and Hamilton (1968) did much to popularize the bid appraisal ratio as a measure of competition in the early 1960's.

[2/] Studies by Haynes (1979) and Wiener (1979) have used overbid as a measure of competition.

costs for the assumed mix of products are $42 and $57 per thousand, respectively, and road costs and the estimate for profit and risk are $5 and $16 per thousand. The appraised stumpage price (A) is then

$$A_j = S_j - (L_j + M_j + R_j + P_j); \quad (1)$$

where

S_j is the selling price for the j^{th} sale,
L_j is the logging cost for the j^{th} sale,
M_j is the manufacturing cost for the j^{th} sale,
R_j is the specified road costs for the j^{th} sale, and
P_j is the profit and risk allowance for the j^{th} sale.

In the sample, the appraised stumpage price would be $39 per thousand board feet ($159 - (42 + 57 + 5 + 16)).

In this study, the bid price, various costs, and selling price for individual sales are volume-weighted averages. The total bid price has been adjusted for road costs and corresponds to what is known as the statistical high bid. The appraised price is the volume-weighted average net appraised stumpage price as determined by the USDA Forest Service appraisal system. All data were taken from the standard USDA Forest Service sales report and were deflated by the wholesale price index for all commodities (1967=100) to offset the different rates of inflation in each year of the period covered by the data.

After deflation, the values represented in the study should be interpreted as the value expressed in 1967 dollars (the base year of the index). Furthermore, changes between two points in time should be interpreted as a real change, since inflationary increases have been factored out. The values could be converted to the original form by multiplying the value by the appropriate monthly wholesale price index--all commodities.

THE EFFECTS OF TIME ON THE COMPONENTS OF THE APPRAISAL SYSTEM

A key to evaluating the effectiveness of the bid appraisal ratio and overbid as measures of competition over time is to determine how the components of the appraisal process change over time. As formulated, equation 1 ignores the effect of time, but this can be remedied by including a compound interest factor with each component. The revised equation would be:

$$A(1+i_a)^n = S(1+i_s)^n - [L(1+i_l)^n + M(1+i_m)^n + R(1+i_r)^n + P(1+i_p)^n]; \quad (2)$$

where

n is the number of periods,
$i_a, i_s, i_l, i_m, i_r, i_p$ are rates of change, and
$(1+i)^n$ is the compound interest factor for the i rate of change measured over n periods.

As stated, this relationship allows for different rates of change for each component because individual components change through time at different rates. For example, factors influencing changes in selling price may not be the same as those influencing changes in logging costs.

The importance of considering the effects of time can be illustrated in the following example: Assume that one of four identical sales will be offered each year for 4 years. Assume further that the appraisal components have changed at various rates, leading to a 10-percent-per-year change in the appraised price while overbid has remained unchanged. The changes in major variables of interest are shown below:

Year	Appraised stumpage (A)	Overbid (Ø)	Total bid (B)	Bid appraisal ratio (B/A)
1	39.00	35.00	74.00	1.90
2	42.90	35.00	77.90	1.82
3	47.20	35.00	82.20	1.74
4	51.90	35.00	86.90	1.67

Total bid may be expressed as follows:

$$B\ (1 + i_b)^n = A\ (1 + i_a)^n + Ø\ (1 + i_o)^n. \qquad (3)$$

In the example, the rate of change i_b would have to be less than i_a since i_o is equal to zero.

The example is useful in illustrating the concerns about the uniqueness of the value assigned to a given sale. In the example, differential increases in real costs and prices as reflected in an increasing appraised price led to a declining bid appraisal ratio through time for identical sales. This implies that bid appraisal ratios provide only an ordinal measure in that the assigned value is only relative to other sales observed at the same time. Overbid, in the example, is treated as a cardinal measure; that is, it provides an absolute (or real) measure as well as a consistent measure of competition in each of the 4 years. Overbid is consistent because it measures competition unaffected by differential increases in cost and price elements used in deriving the appraised price.

The example indicates that overbid is a better measure of competition in the sense that it is unaffected by differential rates of real cost and price increases. How realistic is the example, however, and what has been the actual experience in differential rates of inflation in the appraisal elements? These questions can be answered by testing the following hypotheses:

1. There are no real increases in overbid.
2. The rate of real increases in total bid is less than those for appraised price.
3. The rate of real increases in appraised price bears a direct relationship to the rates of real increases in the major components used in computing the appraised price.
4. The bid appraisal ratio declines through time.

The last hypothesis is a direct test of the implications from the first hypothesis. If the first is correct, then the fourth should be correct.

TESTING THE HYPOTHESES

USDA Forest Service sales data from the west side of the Pacific Northwest Region (the Douglas-fir region) were used to test the hypotheses. The data were compiled monthly from the 1,317 sales which were sold between July 1974 and June 1976 and the 652 sales which took place during 1977. The data for appraised price, overbid, and total bid are shown in figure 1; the data for selling price, logging costs, road costs, and manufacturing costs, in figure 2. The bid appraisal ratios, computed as the ratio of total bid and appraised price for the period, are shown in figure 3. The data should be interpreted as simple averages of all sales taking place within each month.

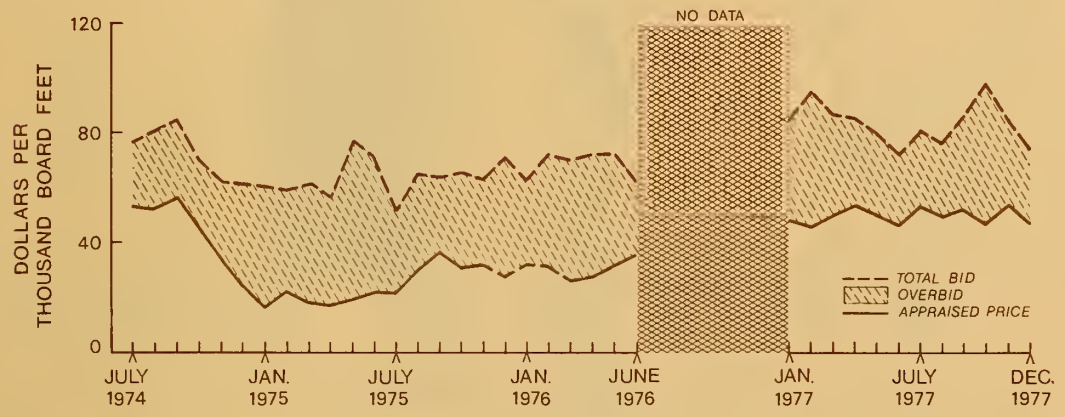

Figure 1.--Appraised price, overbid, and total bid.

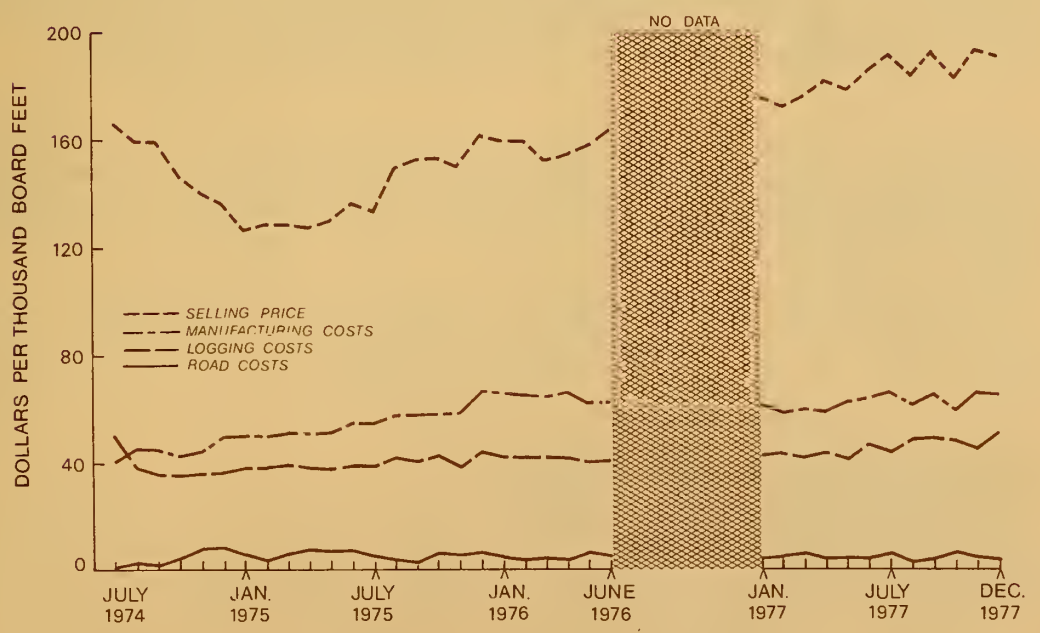

Figure 2.--Selling price, logging costs, manufacturing costs, and road costs.

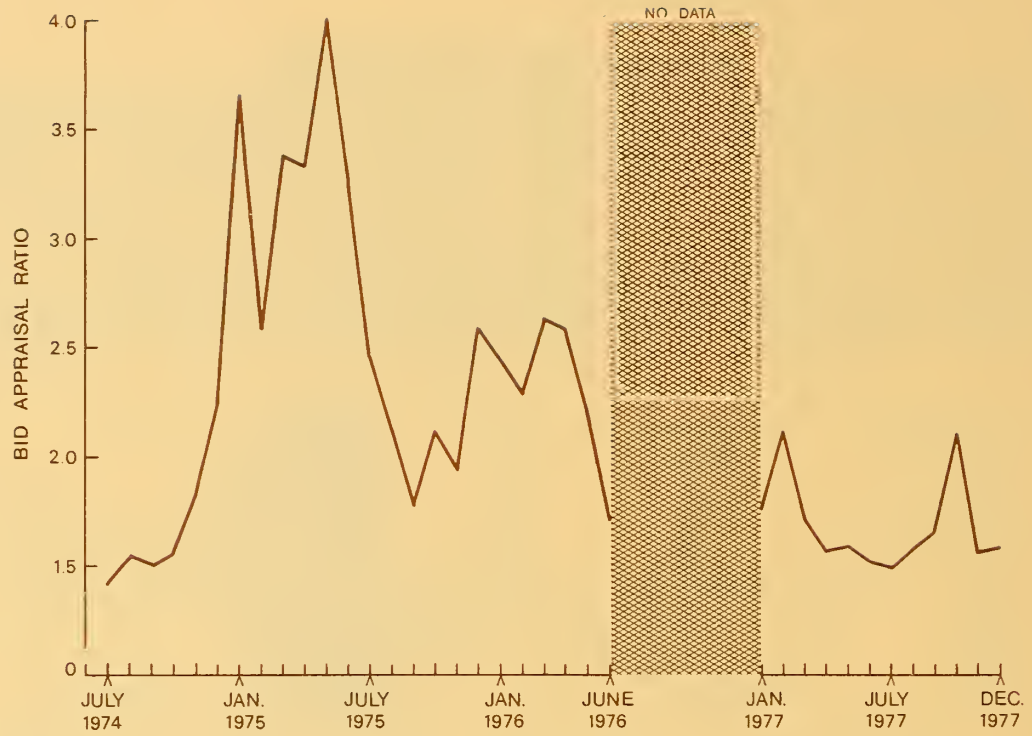

Figure 3.--The bid appraisal ratio.

Although perhaps not typical of the post-World War II period, the price swings in forest products markets, for the period July 1974 through December 1977 are typical of the experience during the last decade. These words of caution should not be interpreted to mean that the study will lead to atypical results. Rapid price movements should have little effect on the appraisal system, except to shift the appraised price up or down as shown in figure 1.

All hypotheses required estimates of the rates of real changes over time. These rates of change were estimated by fitting the variable in question as a function of time using a semilogarithmic functional form. 3/ The coefficient on time was then interpreted as the monthly rate of change. 3/ All estimated equations are shown in table 1.

3/ The particular semilogarithmic form fitted was (for appraised price):

$$\text{Log } A = B_1 + B_2 \text{ time};$$

where

Log is the natural logarithm,
time is an index of months with July 1974=1,
B_1 is the intercept coefficient, and
B_2 is interpreted as $e^{(1 + i)}$, where
i is the monthly rate of increase.

Taking the antilog of B_2 ($\hat{B}_2$) we can solve the relationship,

$$\hat{B}_2 = 1 + i, \text{ and}$$
$$i = \hat{B}_2 - 1;$$

where i is the monthly rate of change in appraised stumpage. This procedure is described in more detail in Johnston (1972).

Table 1--Estimated relationship between elements of appraisal and time

Element	Equation		R^2	Monthly rate of change
	B_1	B_2		
				Percent
Appraised price	[1/] 3.2408 (31.33)	0.0155 (3.62)	0.28	1.562
Overbid	3.5517 (46.67)	-0.0005 (.168)	0	[2/] 0
Total bid	4.1429 (105.21)	0.0067 (4.09)	.33	.668
Road costs	1.5516 (11.18)	0.0003 (.06)	0	[2/] 0
Logging cost	3.6193 (162.67)	0.0051 (5.54)	.47	.511
Manufacturing cost	3.862 (141.03)	0.0086 (7.58)	.63	.863
Selling price	4.8938 (202.74)	0.0082 (8.23)	.67	.825
Bid appraisal ratio	0.9021 (10.63)	-0.0088 (2.52)	.16	-.888

[1/] Student t values appear in parentheses.

[2/] Rates of change were not computed as the B_2 coefficient was not significant.

In the first hypothesis, overbid experienced no statistically significant real changes through time; hence, the hypothesis was accepted. The test of the hypothesis was based on the t statistic which can be interpreted as the estimated coefficient B_2, which at the usual levels of confidence, is in all likelihood equal to zero. The second hypothesis was also accepted, as the rate of real changes in total bid was less than the rate for appraised price. The B_2 coefficients in each equation were significant, and the computed rates of growth (following the procedure outlined in footnote 3) were 0.668 and 1.562 percent for total bid and appraised price, respectively.

Testing the third hypothesis is not as exact a process as testing the first two hypotheses. The rates of change for selling value, logging, road costs, and manufacturing costs were computed by the procedure outlined in footnote 3. No rates of change were computed for the profit and risk component, since the estimate (expressed in percentage) changes mainly through administrative action. The estimated rates support the hypothesis that rates of change in the appraised price vary directly with rates of change in major components. That is not to say that the rate of change for the appraised price is a weighted average of the rates of change for the components. Absolute change

in the appraised price, however, is a weighted sum of changes in the components. There is a need to remember that rates of change are relative measures and that appraised price starts at a lower base. For example, a compound rate of change of 1 percent for 4 years in selling value ($159.00 to $165.50) might translate into a 4-percent change in the appraised price ($39.00 to $45.50) for the same period.

The fourth hypothesis was also accepted. Although the explanatory power of the equation was quite poor, the coefficient on time was statistically significant and was negative.

DISCUSSION

Both bid appraisal ratio and overbid measure competition, but the evaluation of how well depends on individual preferences. Some may prefer the bid appraisal ratio because it explicitly links total bid to appraised price. For example, a bid appraisal ratio of 2.5 implies that the premium for timber on a sale was 2.5 times the appraised price though nothing is known about the magnitudes of the sums involved. On the other hand, overbid is an absolute measure, but to gain the same information one would have to know the appraised price.

The key issue is whether the assigned rating is unique to each sale. From an analytical standpoint, this is critical because analysis of competition invariably involves data collected at different times. The findings for the west side of the Pacific Northwest Region imply that the bid appraisal ratio declines through time as the various components of the ratio experience differential rates of real increases. At the extreme, sales classified as competitive in 1974 might be classified as noncompetitive if they took place in 1977. The extent of the decline can be computed in an average sense. First, the bid appraisal ratio can be computed as:

$$B/A = B\,(1 + i_b)^n / A\,(1 + i_a)^n = [\,A\,(1 + i_a)^n + \emptyset\,(1 + i_o)^n\,]\,/A\,(1 + i_a)^n$$

$$= 1.0 + [\,\emptyset\,(1 + i_o)^n / A\,(1 + i_a)^n\,].$$

If the rates of increase in table 1 for i_a and i_o and the average overbid and appraised price are used, the initial bid appraisal ratio is 1.95 and the ratio at the end of the data period 1.49.

It is true that the 1969 sales in the data period were not equal and that the decline might reflect a lowering of sale quality or other changes over time, but the point remains that bidders did not adjust their real perceptions of the relationship between sales characteristics and overbid. That is, the premium they are willing to pay has remained the same in real terms. Total bid, however, has increased as bidders have compensated for real increases in product prices and processing costs.

This analysis emphasizes the care needed in selecting a measure of competition for empirical analysis. If the analysis involves sales from different years, then overbid is a more reliable measure. The bid-appraisal ratio has declined over time, and use of this ratio to measure competition over time may give misleading results. If the analysis involves only timber sales from the same time, either measure will do an adequate job. The bid-appraisal ratio may be preferred in this case since it provides more information about the timber sale.

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